Detector Installation in the cryostat

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FS Installation Workshop SURF -SD

Outline

- Starting Conditions
- E-Endwall installation
- APA-CPA installation
- W-Endwall and TCO closing

Comment

- Many figures here are old and need updated. As Justin finishes modeling work in the cleanroom effort will start on assembling the detector model(s) for installation.

- Please make sure that tooling models are placed on EDMS so we do not need to hunt for them.

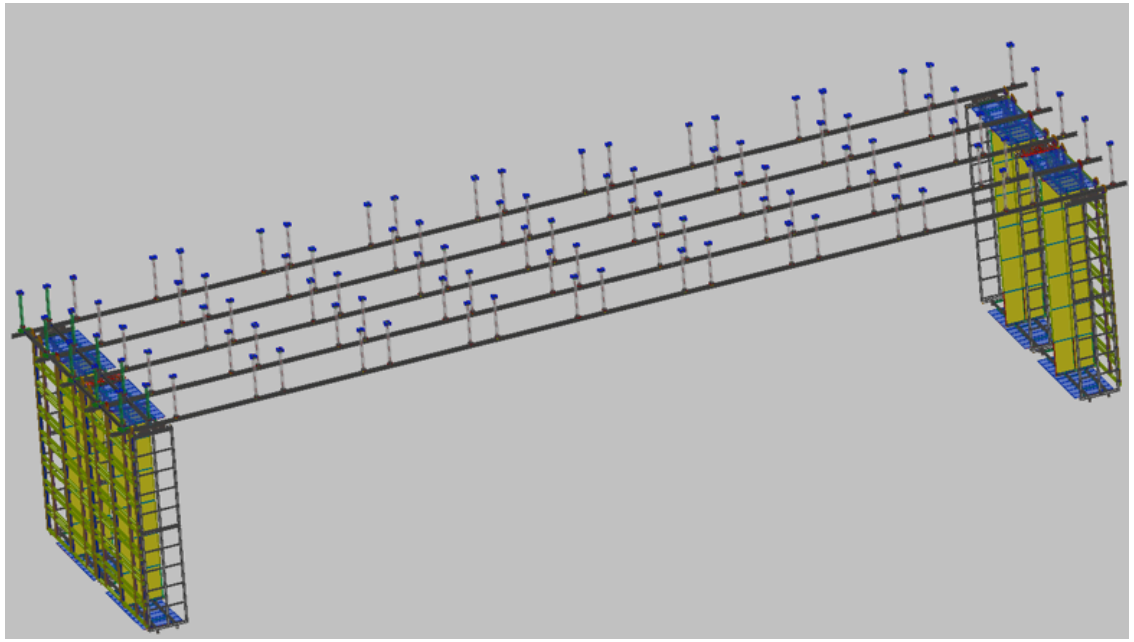
- Models need to be updated regularly

Conditions at the start of the TPC installation inside the cryostat

- The Detector Support System (DSS)
- DAQ
- TPC electronics crosses and WEC on the roof
- Slow control
- Detector Safety System
- Cryostat
- Cryogenic system

Detector Support System (DSS)

- The DSS is installed during cryostat installation.
  - This will allow the use of the scaffolding needed to install the membrane for installing the DSS.
- The DSS will be surveyed in position and the feedthroughs adjusted.
- The flanges will be tight and leak tested.
- The shuttle system will be fully commissioned?
  - May need to be done in parallel to the End Wall installation.



Cryostat Status

- The cryostat is leak tested and clean.
- Cryogenic internal piping is complete
- The temporary floor is installed
- The HVAC is operating according to ISO-14644/ISO-8.
- The cryostat has passed cleanroom inspection
  - Implies particle count survey is done, air velocity OK, and all procedures are in place.

- The outer cleanroom may not be fully operational at the start and a temporary tent outside the TCO may be needed initially.
  - The inside of the cryostat may be used for clean assembly space.

Status at start of TPC installation

- The DAQ has installed and tested a portion of the final system including the racks for rows 1 and row 24 and 25
  - Row 1 will be the first installed.
  - Rows 24 and 25 will supply power to the TPC readout electronics for the coldboxes.
- DAQ installation and testing will proceed in parallel to the detector installation.
- All CE crosses and WEC are installed prior to start of TPC installation.
  - The flanges are closed and light tight. Rubber seals are installed where the flanges will need opened during installation. The CE components are clean.
- Slow control oversight is debugged and operational

Start Installation

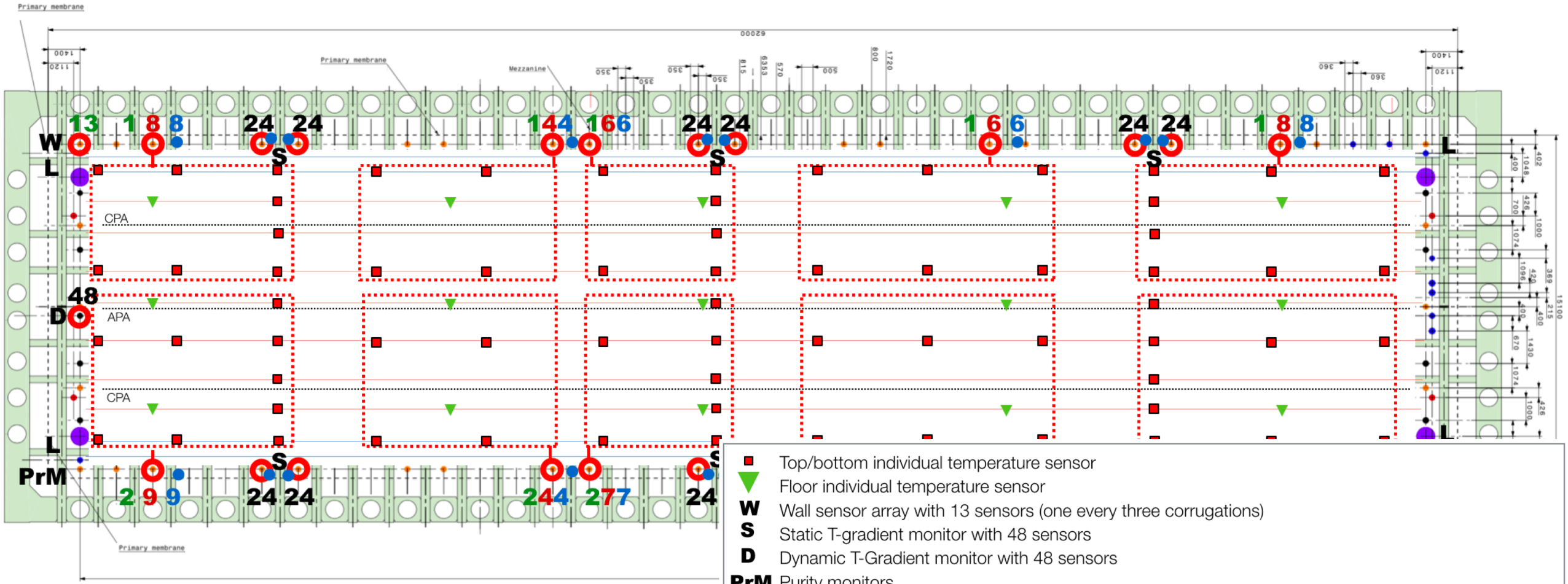
CISC Initial Installation

- The CISC groups plans to install all the cable harnesses at the beginning of the installation.
  - Thermometry is distributed under the floor, up the walls and will be places on the ground planes.
  - Thermometers will be installed later to protect them.
  - Purity monitors, Capacitance level meters and possibly cameras will be installed near the East wall.

- The number and location of the sensors needs fixed.
- The interfaces need to be defined especially for the cabling.
- After this a reasonable time and labor estimates can be established.

- Here it is assumed that the cryogenic instrumentation and the End Wall can be installed in a 1 month period.

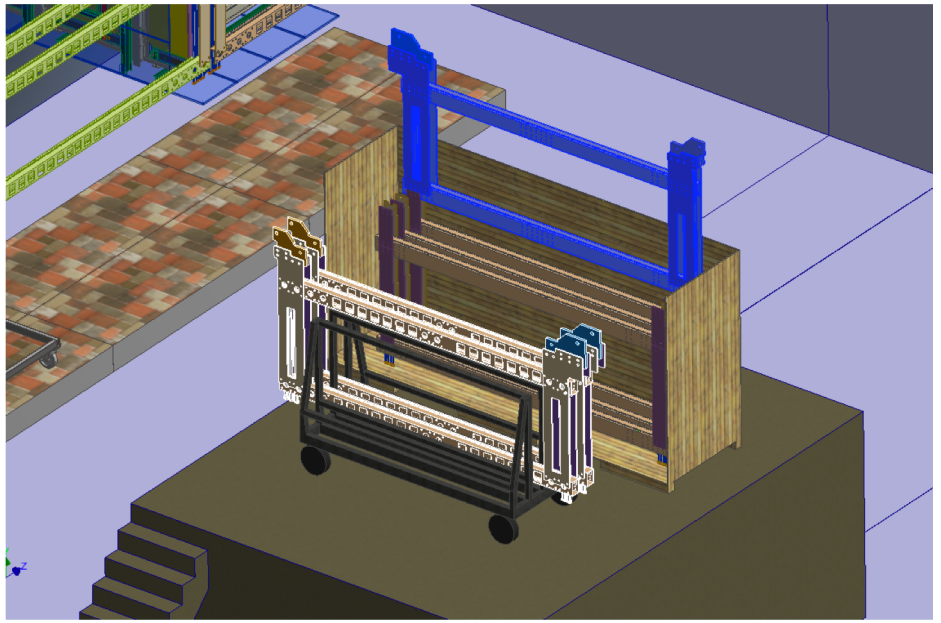
CISC Sensor Placement Map



- Top/bottom individual temperature sensor
- Floor individual temperature sensor
- **W** Wall sensor array with 13 sensors (one every three corrugations)
- **S** Static T-gradient monitor with 48 sensors
- **D** Dynamic T-Gradient monitor with 48 sensors
- **PrM** Purity monitors
- **L** Capacitive level meters
- Vertical SS string
- DSS port used for temperature sensors
- Individual sensors associated to a DSS port (same for top and bottom)
- **8** Number of cables in each port (**black** for T-Gradient, **red** for top, **blue** for bottom, **green** for floor/wall)
- Gas purge pipes
- Liquid argon return pipes

East End-Wall installation

- The HV group's plans is to assemble the FC modules in the cleanroom underground. However the cleanroom will not be ready before the installation start date. A temporary tent may be required for two months until the cryostat is clean.
- 8 End Wall modules are needed to build one End Wall plane.
- 4 End Wall Planes are needed for the full End Wall
- A cart which allows easy transport of 4 End Wall modules will be provided by the HV group.

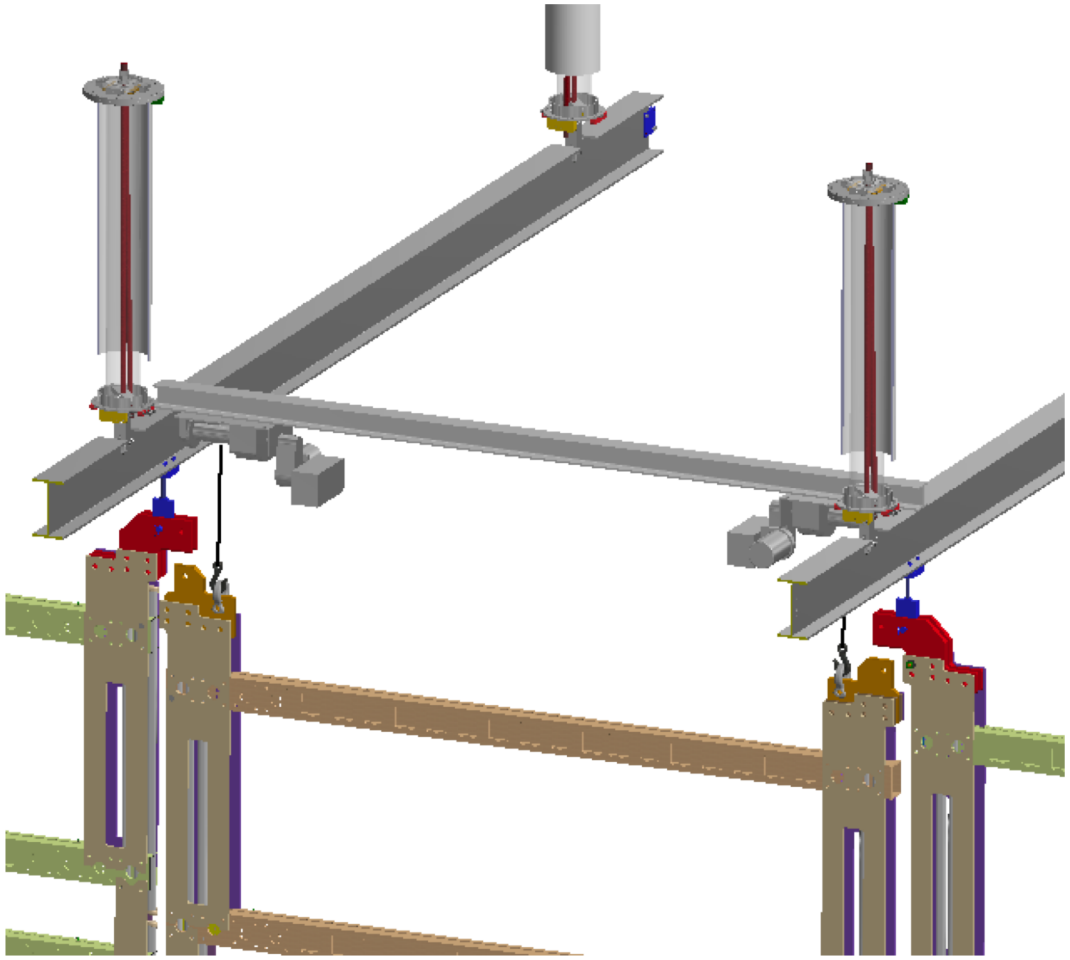


If the EW are constructed underground then the transport crate shown on the right is not needed.

East End-Wall installation

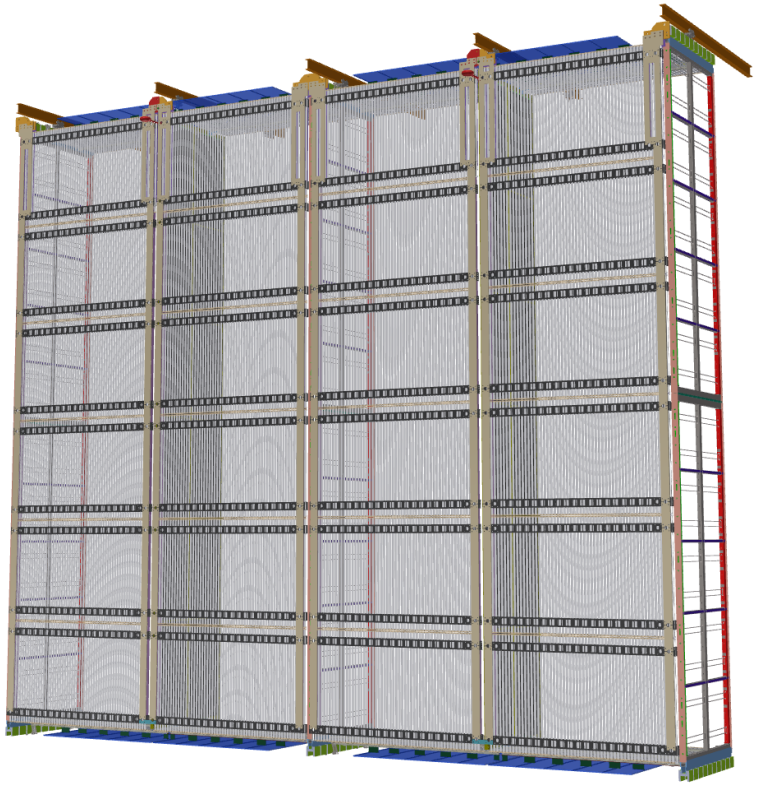
- A hoist fixture is attached between the DSS beams and cables are attached to the EW module.
- The module is lifted until the cart can be shifted over and an additional module is attached to the first.
- This is repeated for all 4 modules.
- Assume this is day shift only.
- 2.5 weeks

Activity	Duration	JPO Crew	HV team
Setup hoist + Position EW cart	4	4	2
Lift EW modules and assemble in plane	8	4	2
Test/qualify EW plane	4	2	4
Survey Panel Position	4	3	1



East End-Wall installation

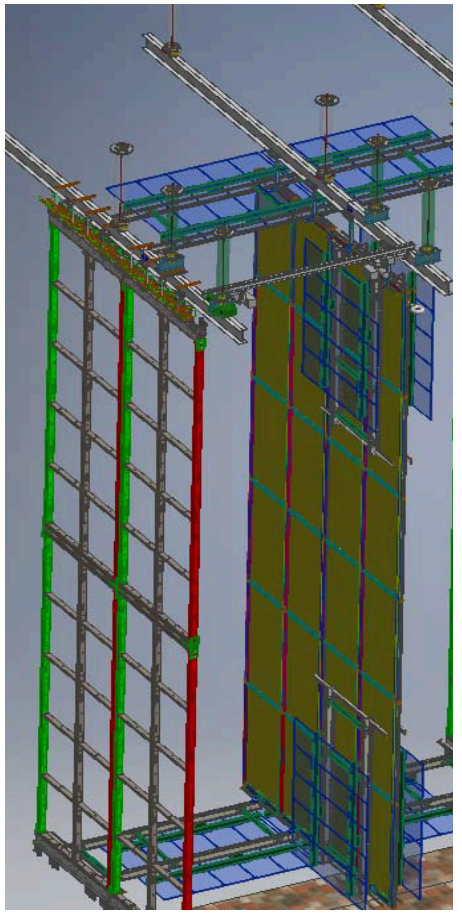
- The actual End Wall installation process will take 2.5 weeks. However additional time should be planned as this is one of the first elements to be installed.
- The implies the CISC will need to be finished near the east wall after roughly one week.
- One week of schedule contingency is in the plan but that is not very much.

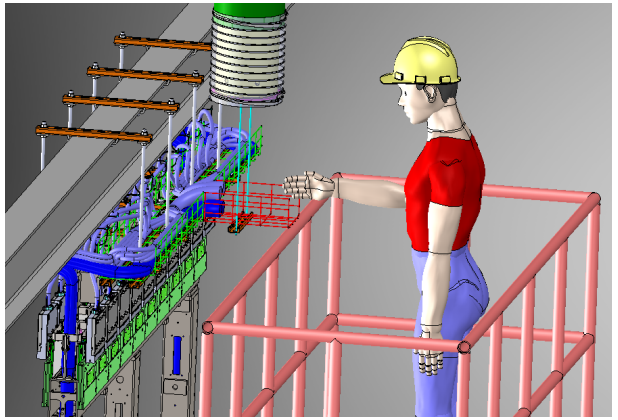


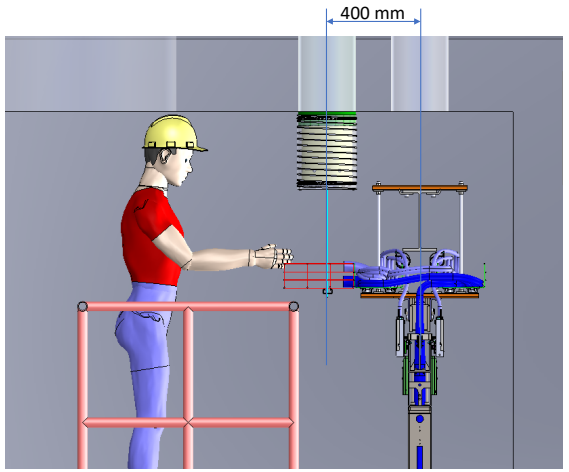
APA Installation

- One month is planned for the installation of the first row. This will give time to de-bug the installation procedures and also perform extensive tests of the APA and photon systems.
- After the first row of APA is is planned to install one row or 3 APA pairs per week.
  - The TCO should be closed on Fridays for noise monitoring and photon testing over the weekends and re-opened Sunday.
- Installing the last row of APA is more complicated as the switchyard must be removed. One month is planned for the last row.

		# Months	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Assembly SP Dec #1	**DUNE**	**13**	**Assembly SP Decector #1 10 months**														
Pre and install West End Wall	DUNE	3	End														
Start-up APA-CPA-FC 1-2	DUNE	1.5		1	2												
Install APA-CPA-FC 3-24	DUNE	5.5			Install APA/HV 3-24												
Install APA-/HV 25	DUNE	1									25						
Pre and install East End Wall	DUNE	3								Prep		End					
TCO Closing	CERN	2											TCO				
Final Assembly Completion	DUNE	1													Final		





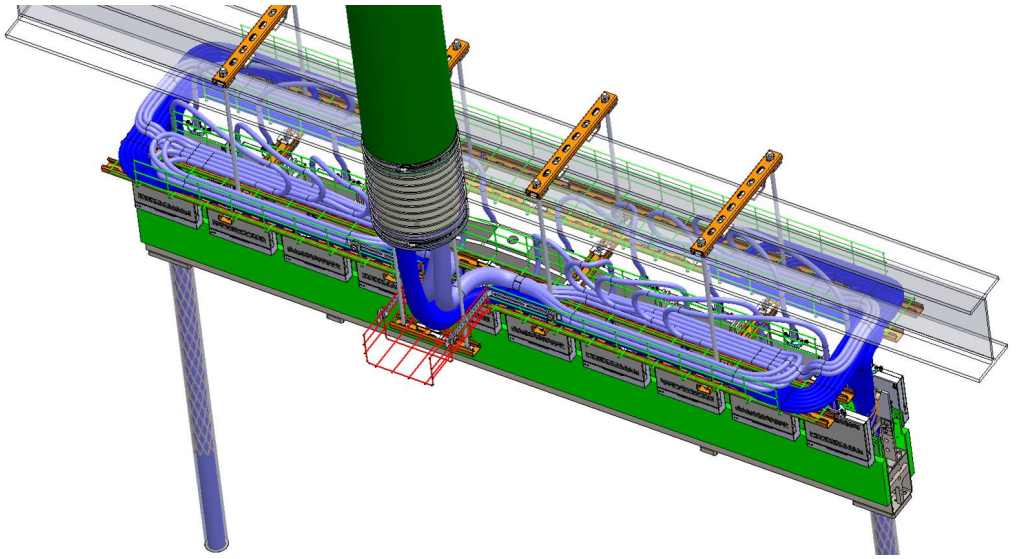


J-Tech = JPO technician

APA installation

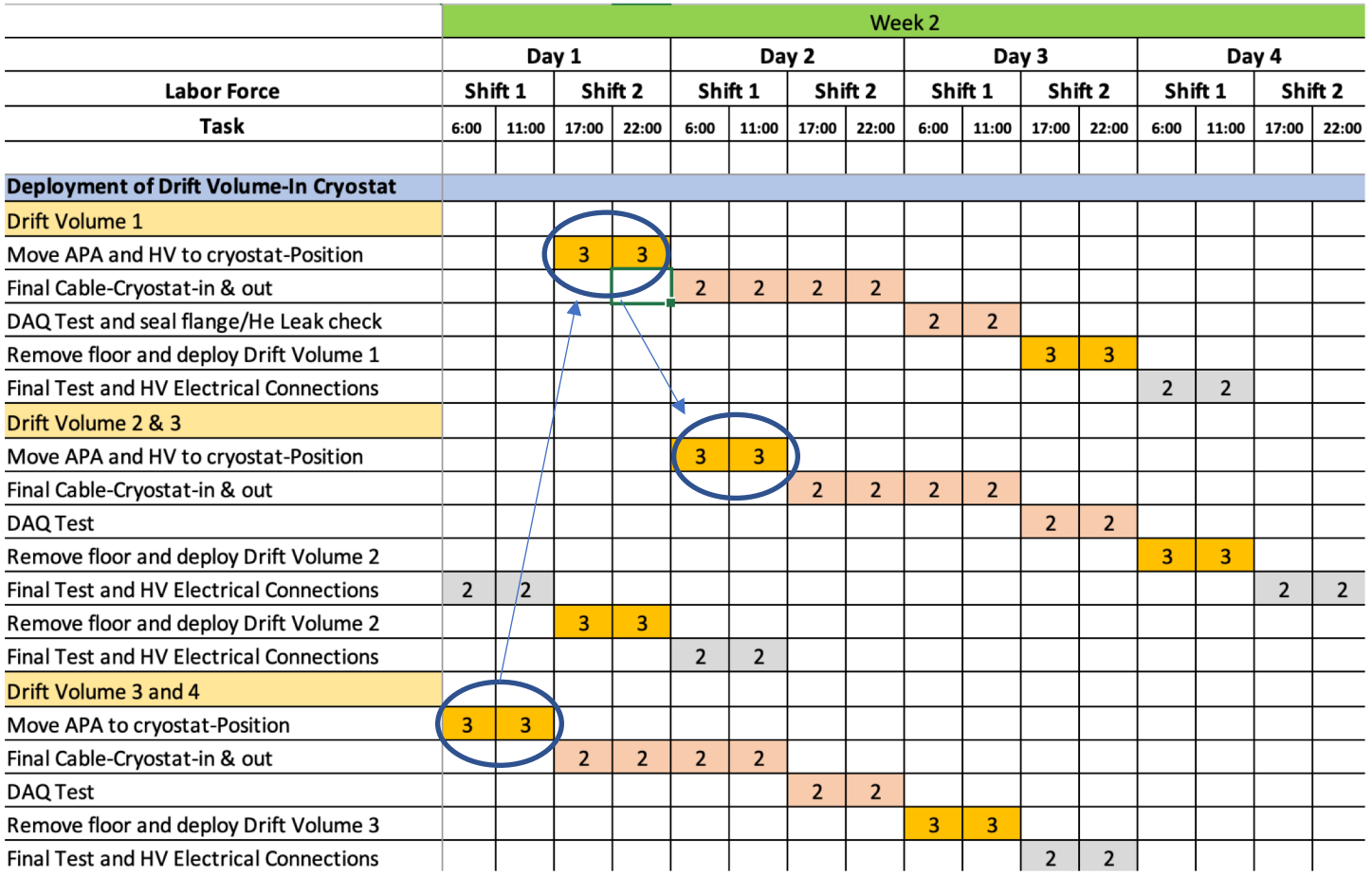
- APA are moved into position by 3 J-Tech. (8hr)
- Two J-Tech inside and 2 CE tech outside route the cables (16hr)
- Two J-Tech seal the flanges while 2 CE test the electronics (8hr)
- Three J-Tech remove the floor and deploy the FC (8hr)
- One CE and two HV perform final test and QA (8hr)

							Week 2															
							Day 1				Day 2				Day 3				Day 4			
Labor Force					Colla		Shift 1		Shift 2		Shift 1		Shift 2		Shift 1		Shift 2		Shift 1		Shift 2	
Task					bora		6:00	11:00	17:00	22:00	6:00	11:00	17:00	22:00	6:00	11:00	17:00	22:00	6:00	11:00	17:00	22:00
	APA	CE	PD	HV	tors	JPO																
Deployment of Drift Volume-In Cryostat																						
Drift Volume 1																						
Move APA and HV to cryostat-Position						3			3	3												
Final Cable-Cryostat-in & out		2				2					2	2	2	2								
DAQ Test and seal flange/He Leak check		2				2									2	2						
Remove floor and deploy Drift Volume 1						3											3	3				
Final Test and HV Electrical Connections		1		2															2	2		
Drift Volume 2 & 3																						
Move APA and HV to cryostat-Position						3					3	3										
Final Cable-Cryostat-in & out		2				2							2	2	2	2						
DAQ Test		2															2	2				
Remove floor and deploy Drift Volume 2						3													3	3		
Final Test and HV Electrical Connections		2		2			2	2													2	2
Remove floor and deploy Drift Volume 2						3			3	3												
Final Test and HV Electrical Connections		1		2							2	2										
Drift Volume 3 and 4																						
Move APA to cryostat-Position						3	3	3														
Final Cable-Cryostat-in & out		2				2			2	2	2	2										
DAQ Test		2											2	2								
Remove floor and deploy Drift Volume 3						3									3	3						
Final Test and HV Electrical Connections		1		2													2	2				



Optimizing work flow

- Ideally one crew would move APA and one team test CE. However these overlap now.
- Need to optimize to efficiently use people.
- Will still need to have crews trained at multiple stations.



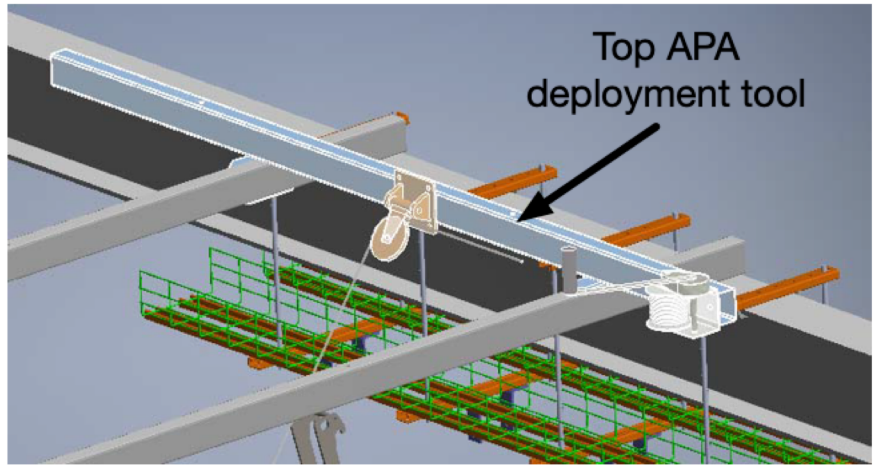
	Week 2															
	Day 1				Day 2				Day 3				Day 4			
Labor Force	Shift 1		Shift 2		Shift 1		Shift 2		Shift 1		Shift 2		Shift 1		Shift 2	
Task	6:00	11:00	17:00	22:00	6:00	11:00	17:00	22:00	6:00	11:00	17:00	22:00	6:00	11:00	17:00	22:00
Deployment of Drift Volume-In Cryostat																
Drift Volume 1																
Move APA and HV to cryostat-Position			3	3												
Final Cable-Cryostat-in & out					2	2	2	2								
DAQ Test and seal flange/He Leak check									2	2						
Remove floor and deploy Drift Volume 1											3	3				
Final Test and HV Electrical Connections													2	2		
Drift Volume 2 & 3																
Move APA and HV to cryostat-Position					3	3										
Final Cable-Cryostat-in & out							2	2	2	2						
DAQ Test											2	2				
Remove floor and deploy Drift Volume 2													3	3		
Final Test and HV Electrical Connections	2	2													2	2
Remove floor and deploy Drift Volume 2			3	3												
Final Test and HV Electrical Connections					2	2										
Drift Volume 3 and 4																
Move APA to cryostat-Position	3	3														
Final Cable-Cryostat-in & out			2	2	2	2										
DAQ Test							2	2								
Remove floor and deploy Drift Volume 3									3	3						
Final Test and HV Electrical Connections											2	2				

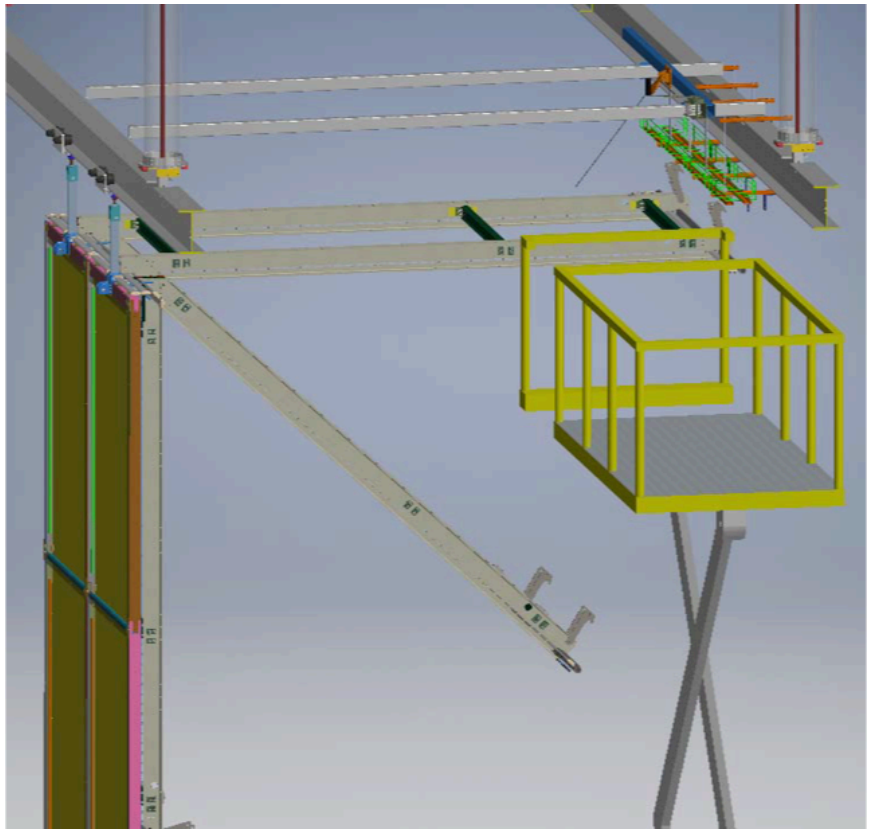
CPA/FC installation

- The HV system design is changing and the installation process and interfaces will need updated.
  - Major changes include the installation of the ground plane on the DSS and deployment of the lower FC.
- The movement of the CPA into position is similar to the action of moving the APA into position and will be done in parallel.
- Schedule shown above does not include an activity for electrically connecting the CPA to its neighbor and testing continuity. This needs added. (2 HV people 2hr?)
- Do we immediately deploy the FC or wait till the end?
  - If cleaning at the end is needed then we need to wait till the end.
  - Late deployment means deploying FC, removing all the floor panels and lights, and cleaning after the APA can no longer be remove for repair.
  - Can we decide now?

FC top deployment

- Deploying the top FC requires placing the temporary hoist tooling over the drift volume, attaching the cable to the panel, and lifting it till it latches.
- Electrical connections are made and tests are performed after the panel has latched.
- 3 J-Tech are planned 4 hours for this work and 2 HV(testing).





FC bottom deployment

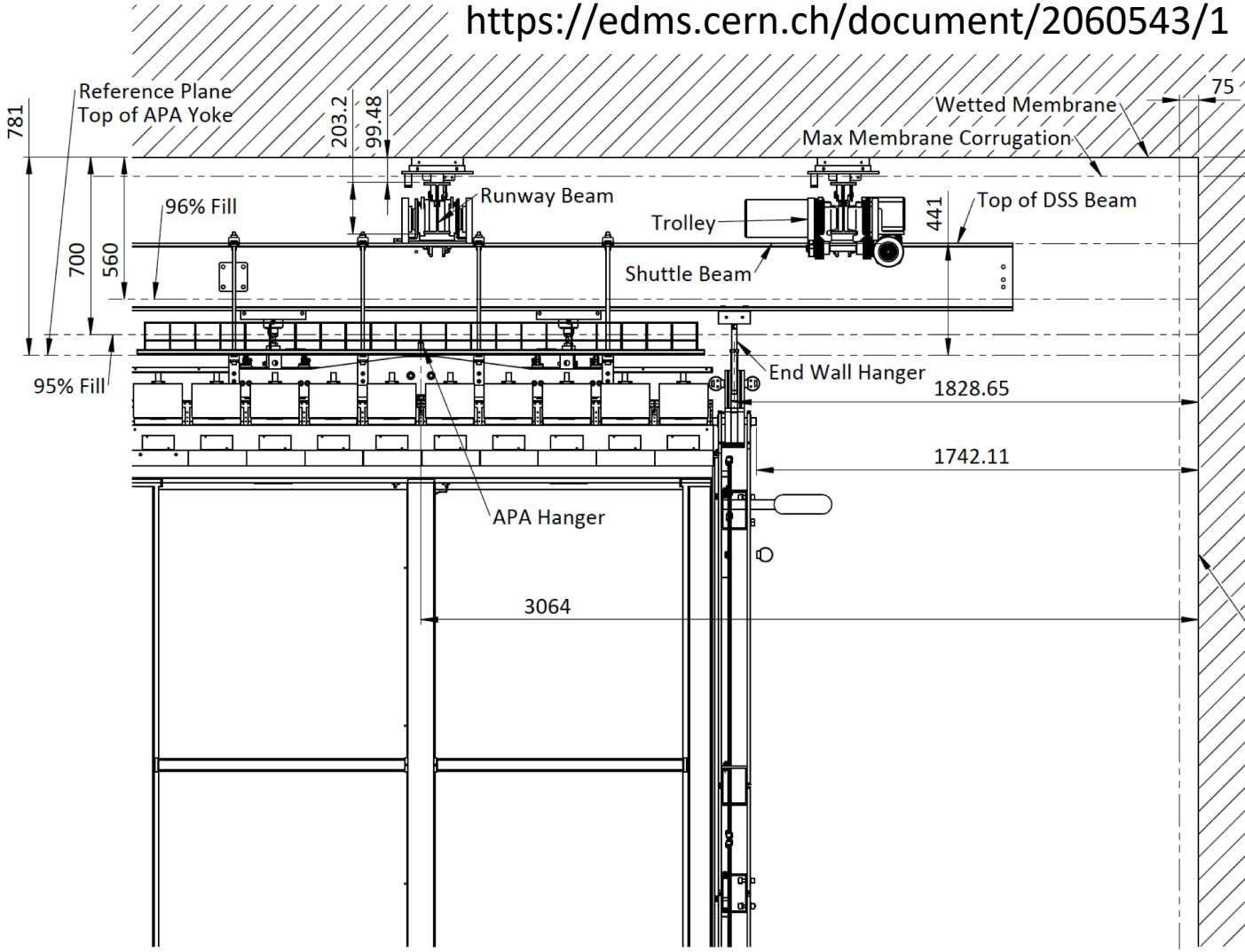
- It is likely that the lower FC panels will be attached to the cathode when entering the cryostat.
- A cart may be used to lower tFC modules but this must be tall and is cantilevered as the floor panels need to be removed before the panel is lowered.
- Other tooling is being considered.
- 3 J-Tech for 4 hr are budgeted for the lowering process and all connections.

							Week 2											
							Day 1				Day 2				Day 3			
Labor Force					Colla		Shift 1		Shift 2		Shift 1		Shift 2		Shift 1		Shift 2	
Task					bora		6:00	11:00	17:00	22:00	6:00	11:00	17:00	22:00	6:00	11:00	17:00	22:00
	APA	CE	PD	HV	tors	JPO												
Remove floor and deploy Drift Volume 1						3											3	3

End Wall and TCO closing

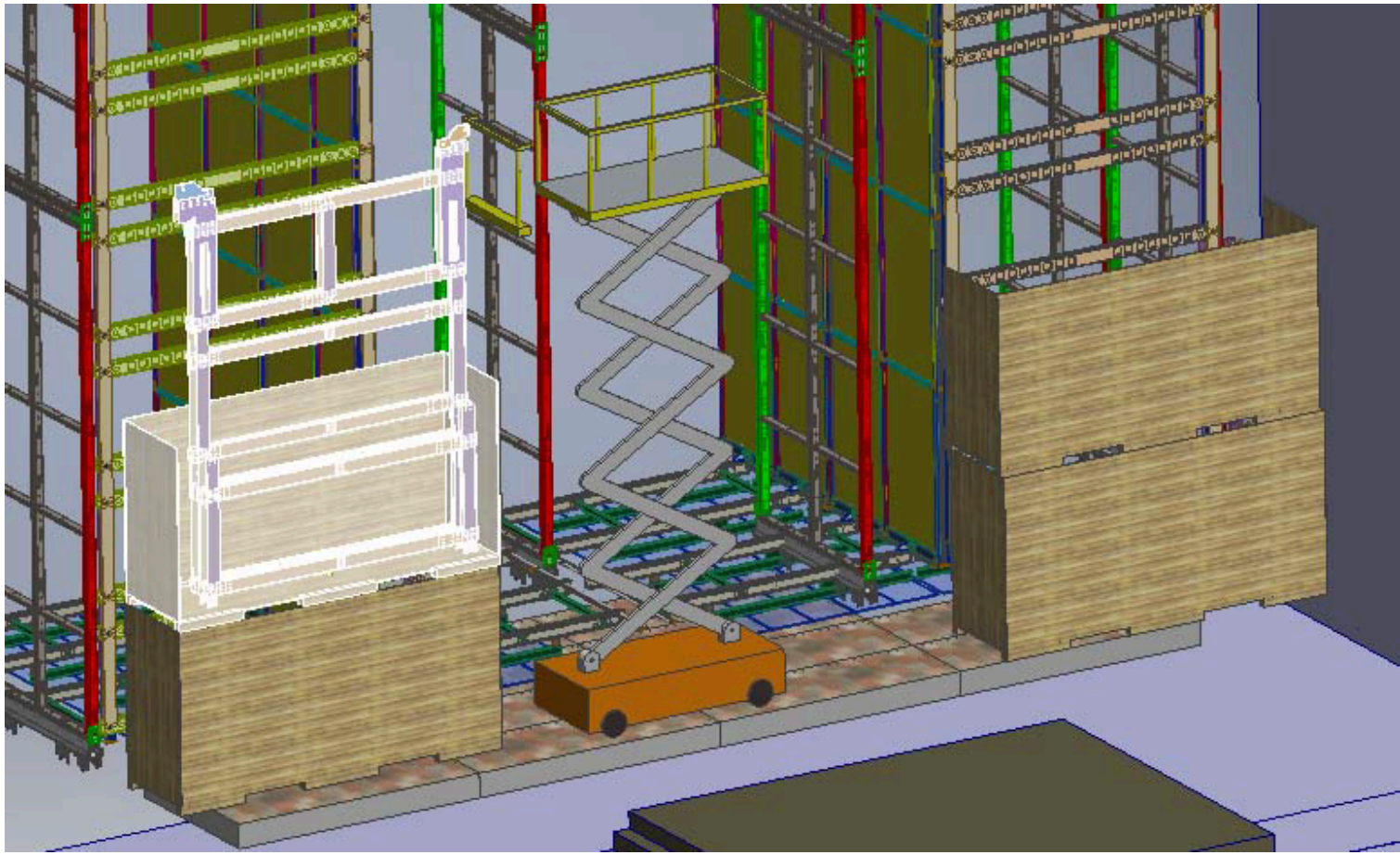
- The 1.7m pace between the end wall and the membrane is considered sufficient to close the TCO. This will allow the full end wall to be installed prior to TCO closing.
- The scissor lift will then need to be craned out using the TOC beam and hoists.
  - Space is tight.

https://edms.cern.ch/document/2060543/1



West End Wall Installation

- The EW are brought in using the same cart as before.
- There is enough space for someone to stand between the wall and the cart to connect the lifting cables.
- The hoist will need operated from the side of the EW.
- Two weeks should be adequate to install the end wall if all goes smoothly.
- Two additional weeks are planned to prepare for the TCO closing.
- 3 J-Tech to move and hoist the EW panels.



Post TCO closing

- Scaffolding and temporary lighting need installed through the manholes.
- Protective covers need removed.
- The EW need inspected.
- The area needs cleaned.
- Final CISC instrumentation is installed.
- The HV feedthrough is installed.
- The scaffolding is removed.
- The manholes are closed.
- Roughly 1 month of labor.

Conclusions

- The basic process for the installation is understood but many of the details are missing.
- Interfaces to the CISC and CAL need to be defined but first a clear definition of scope is necessary.
  - Models for the CISC equipment are needed.
  - Cable routing, mechanical mounting, camera mounting and gas connection.
- The interfaces need refined between all components including the installation equipment.
- Models for tooling and fixtures need to be on EDMS.
- The installation procedures and testing need developed.